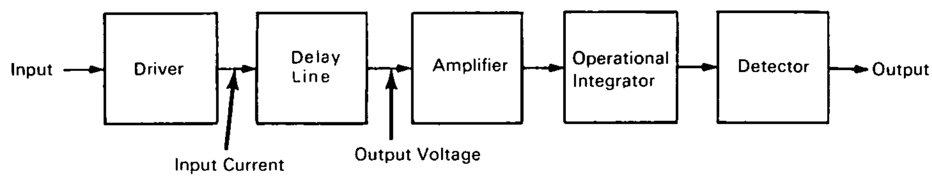
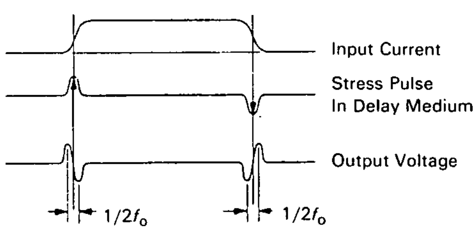
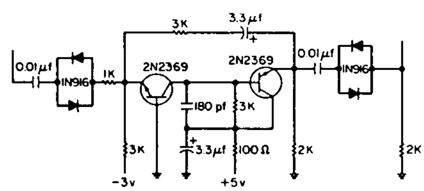
December 1968 Brief 68-10547

NASA TECH BRIEF

Operational Integrator







In the usual technique for storing digital information of an aperiodic nature, the information is applied to a delay medium and later retrieved in identical format. In many such techniques, transients (noise pulses) can interfere with input pulse sequence in a manner that destroys the integrity of the original information. Such unpredictable limiting conditions reduce accuracy of the retrieval of information presented to the delay line. In the past, designers chose to attenuate the problem by return-to-zero clocked pulse techniques.

The system described here operates in the nonreturn-to-zero mode, maintaining the increased bit density capability of this mode but with much higher noise immunity than conventional schemes offer. The complete system (shown in the upper figure) has a driver circuit converting input voltage pulses into current pulses of specific magnitude. These are fed into the delay line portion of the system.

Typical waveforms within ultrasonic delay lines, such as magnetorestrictive lines, glass lines or others, are shown in the lower left figure. This represents an idealized timing diagram where an input current step is applied to the launch coil, causing a mechanical stress pulse in the delay medium to propagate through the line at a certain velocity. It is to be noted that this stress pulse is proportional to the derivative of the input current step. The response of the output pickup coil to the stress pulse is a voltage waveform which is proportional to the second derivative of the input current step.

This output waveform is now (again referring to the upper figure) amplified several hundred times and fed to an operational integrator in order to present the

(continued overleaf)

detector with a signal free of the limiting uncertainties (transient noise effects) discussed previously. The result is a more reliable and predictable system since sporadic noise transients of appreciable amplitude are largely attenuated. Additionally, a simpler detection technique can be used by feeding the positive pulses to the "set" side and the negative pulses to the "reset" side of a bistable device. In the present system, the signal is detected by a Schmitt trigger.

The operational integrator, which is the innovation in this system, is illustrated in the lower right figure and features a "dead space" generator at both input and output for the purpose of removing baseline noise. The baseline noise at the input is primarily caused by the delay line itself, while the output baseline noise is caused by dissymmetry of the input signal. This results in undesirable baseline offset and requires excessive filtering of the +5v supply in order to maintain purity of the integration process. Removal of baseline noise through the use of "dead space" generators relaxes this requirement.

Notes:

1. In tests, power supply variations in excess of ±10% resulted in no deterioration in performance.
2. The integrator described performs a mathematical integrating function on inputs from 100 Hz through 100 MHz.
3. Documentation for the innovation is available from:

   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: B68-10547

Patent status:

This invention is owned by NASA and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

Source: Erno B. Lutz
Jet Propulsion Laboratory
(NPO-10230)